SVKM's

D. J. Sanghvi College of Engineering

Program: B.Tech in Chemical Engineering | **Academic Year: 2022** | **Duration: 3 hours**

Date: 05.01.2023

Time: 10:30 am to 01:30 pm

Subject: Chemical Reaction Engineering - I (Semester V) | **Marks: 75**

Instructions:

(1) All Questions are Compulsory.
(2) Assume suitable data wherever required, but justify it.
(3) All questions carry equal marks.
(4) Answer to each new question is to be started on a fresh page.
(5) Figure to the right indicate full marks.
(6) Use of statistical table is allowed.

Question No.		Max. Marks
Q1	Solve any three.	
	1. Write advantages and disadvantages of continuous reactor, ~~and batch reactor~~.	05
	2. Differentiate between molecularity and order of reaction.	05
	3. Write short note integral method of analysis	05
	4. On doubling the concentration of the reactant, the rate of reaction triples. Find the order of the reaction.	05
	5. Differentiate elementary and non-elementary reactions.	05
Q2 (a)	At 500 K, the rate of a bimolecular reaction is ten times the rate at 400 K. Find the activation energy for this reaction using 1. Arrhenius Law 2. Transition complex theory	08
Q2 (b)	At certain temperature, the half-life periods and initial concentrations for a reaction are $t_{1/2} = 420$ sec, $CA_0 = 0.405$ mol/lt and $t_{1/2} = 275$ sec, $CA_0 = 0.64$ mol/lt. Find the rate constant of a reaction.	07
	OR	
Q2 (b)	Write advantages and disadvantages of batch ~~and continuous~~ reactor.	07

Q3 (a) Calculate the first order rate constant for the disappearance of A as per the gas phase reaction A $\rightarrow$ 1.7 R. If the volume of the reaction mixture, starting with pure A increases by 50 % in 4 minutes. The total pressure of the system remaining constant at 1.2 atm and the temperature is 25 ^{0}C. 08

Q3 (b) The activation energy of a chemical reaction is 16895 cal/mol in the absence of catalyst and 10585 cal/mol in the presence of catalyst. By how many times will the rate of reaction will grow in the presence of a catalyst if the reaction proceeds at

350 K. 07

OR

Q3 (b) Derive an integrated rate expression for the following irreversible second order reaction in terms of conversion in case of constant volume batch reactor. 07

Assume different values of C_{A0} and C_{B0}. The reaction is as follows:

$$A + B \rightarrow R + S$$

Q4 (a) We are planning to operate a mixed flow reactor to convert Reactant A into R. This is a liquid phase reaction with the stoichiometry A $\rightarrow$ R. The rate of reaction is given in the following table. 08

1) What size of mixed flow reactor is needed for 75 % convenrsion of a feed stream of 2000 mol A/hr at C_{A0} = 1.2 mol/lt ?

Data:

C_{A}, mol/lt	0.1	0.3	0.5	0.7	1	1.3	2
$-r_{A}$,,mol/lt.min	0.1	0.5	0.5	0.1	0.05	0.045	0.042

Q4 (b) Liquid reactant A decomposes as follows: 07

A $\rightarrow$ R $r_R = K_1 C_A^2$ $K_1 = 0.5$ m^3/mol.min

A $\rightarrow$ S $r_S = K_2 C_A$ $K_2 = 2.5$ min^{-1}

A feed of aqueous A (C_{A0} = 50 mol/m^3) enters a reactor, decomposes and a mixture of A, R and S leaves the reactor. Find C_R, C_S and τ for X_A = 0.8 in a mixed flow reactor

OR

Q4 (b) The elementary reaction A +B $\rightarrow$ C +D is effected in a setup consisting of a mixed flow reactor in which two solution are introduced followed by a PFR. The component B is in excess so that the reaction is a first order with respect to A. various ways to increase the production rate are suggested, one of which is to reverse the order of reactor units. How would this change affect the conversion 07

Q5(a) Ethanol is esterified to produce ethyl acetate and H_2O at 1 atm according to the reaction, 08

$$CH_3COOH_{(l)} + C_2H_5OH_{(l)} \rightarrow CH_3COOC_2H_{5\,(l)} + H_2O_{(l)}$$

What is the equilibrium constant for reaction at 100 ^{0}C? What is the composition of the mixture if initially 1 mole of acetic acid and 1 mole of ethanol were present?

Data:

ΔG^0 = 1160 cal

ΔH_R^0 = 1713 cal

Q5(b) The standard heat of gas phase reaction at 25 ^{0}C 07

$A + B \Rightarrow 2R$ is $\Delta H_R^0 = -40000$ J.

Indicating the reaction is strongly exothermic. It is planned to run this reaction at 1000 ^{0}C. What is the value of heat of reaction at that temperature? Is the reaction still exothermic at 1500 ^{0}C?

Data: $Cp_A = 34$ J/mol.k

$Cp_B = 46$ J/mol.k

$Cp_R = 71$ J/mol.k

OR

Q5(b) Write short note on optimum temperature progression. 07